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# Foreign exchange markets in transition economies: China

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**Abstract**

The purpose of the paper is to examine the behaviour of exchange rates in China during the recent period of trade and exchange system reforms. A simple theoretical model based on the monetary approach is developed to explain the exchange rate in the parallel or black market, given the official and substantially controlled rate. The model is tested on quarterly data using the cointegration technique, error correction modeling and impulse response analysis. The results confirm the main features of the model and have policy implications concerning the use of devaluation and monetary policy for stimulating the economy, and the adoption of policies, which encourage black market activities. 

*JEL classification:* F31
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## 1. Introduction

One striking feature of the Chinese economy since 1978 has been the co-existence of planned and market prices in many areas of the economy. In the foreign

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exchange market, three types of exchange rates have co-existed. The official rate, which was fixed and rarely changed; the swap rate, which was used by Chinese enterprises to swap their foreign exchange quotas and/or foreign currencies at a state determined rate by the Bank of China in selected cities, and which was less managed since 1988; and the black or parallel market rate, which was market-determined. The black market emerged because of the government's attempts to set the exchange rate and to monopolise access to and use of foreign currencies.

In this paper, we concentrate on the behaviour of the black market rate since 1988. We develop a simple theoretical framework for a country, like China, with an underdeveloped financial system and where access to credit has been largely controlled by the state, limiting the possibilities for interest rate arbitrage. The model is within the class of monetary models to exchange rate determination, which have been initially developed for the official exchange rate.[1] In our model the money market is what has been driving the black market rate. Such a framework is more suitable than the portfolio balance models, which emphasize amongst other factors portfolio considerations based on the interest rate differential.[2] It is also considered more appropriate than the "smuggling and real trade models", which emphasize the transactions demand for foreign exchange and analyse the impact of trade restrictions assuming away the portfolio motive completely.[3] Although import tariffs existed in China, the average tariff rate was reduced substantially during the period of examination, from 29.2% in 1988 to 19.8% in 1996 (see World Bank, 1997). In contrast to the relaxation of tariffs, capital account inconvertibility has remained throughout the period of examination, encouraging agents to participate in the black market. The monetary approach framework applied in this study has the additional advantage of allowing one to examine the effects of monetary policy on the economy and the financial markets, which is a useful exercise in view of the emphasis on financial policies in post reform period.

The paper contributes to the literature as follows. First, it is the first study of its kind which attempts to examine the interaction between the black market rate and the swap rate in China in recent times following the drastic economic and financial reforms. The swap rate was a more representative state rate for the period 1988 to 1993 than the official rate, since an increasing amount of transactions were channeled through that market. In 1994 the official rate and the swap rate were unified. Previous studies, such as that by Yin and Stoever (1994), have looked at the black market premium, defined as the spread between the black market rate over the official rate. They applied a version of the portfolio approach using

[1] For a review of the various models, see Phylaktis (1996).
[2] For an exposition of the portfolio balance models, see e.g. Phylaktis (1991).
[3] See e.g. McDermott (1989).

ARIMA models over the period 1975 to 1992 and found that depreciation adjusted interest rate differential was not statistically important, while the real official exchange rate was.

Second, we employ in our study the econometric technique of cointegration, which takes into account the non-stationarity of variables, to explore the long-run relationship between the black market rate, the swap rate and the monetary factors. Real output is allowed to play a role in the determination of the black market rate through the demand for real money balances. Furthermore, by examining the short-run dynamics of the model and applying impulse response analysis we find some interesting results concerning the interactions amongst the variables. For example, we explore the effects of a devaluation of the officially controlled rate on real output and the inflation differential, as well as the effects of the black market rate on the economy. We also gain an insight into the effectiveness of monetary policy. These results have policy implications concerning the use of devaluation and monetary policy for stimulating the economy, and the adoption of policies that encourage black market activities.

The paper is structured as follows. In Section 2, we give an overview of the exchange markets in China. In Section 3, we present the model. In Section 4, we discuss some stylised facts on the black and swap exchange rates, present the empirical findings and consider their economic interpretation. In the Section 5, we give a summary and discuss some policy implications.

## 2. Overview of the exchange markets in China

Active black markets for foreign currency emerge primarily because of direct and indirect official intervention in the foreign exchange market. In China, black market transactions have been a keystone of economic activity and monetary life for over half a century. The fixing of the exchange rate and use of restrictions governing access to the foreign exchange market have resulted in a thriving black market. The suppliers of foreign currency to the black market have been local residents connected with the tourist industry, Chinese from Hong Kong, Macao and Taiwan making frequent trips to the mainland, Chinese leaving abroad and making remittances to China, and locals shipping silver, jade, antiques and herbs —opium—out of the country. Before the unification of the swap and official rates in 1994, both the private and the state-owned enterprises provided a large share of currency to the black market by channeling their unused “foreign exchange retention quota” and the excess foreign currency from underinvoicing of exports and overinvoicing of imports.

The demand for foreign currency in the black market came from those who traveled abroad for a holiday or to study; from the private and state enterprises, which urgently needed foreign currency to import raw materials and equipment;

and from the people who smuggled goods, such as cars, television sets and cigarettes into China.[4]

The volume of transactions in the black market is difficult to measure. An indication of the size of the market is given by the General Administration of Customs, which reported that the volume of smuggling uncovered amongst private enterprises and state owned companies amounted to 1.22 billion renminbi during the first half of 1994. Furthermore, one-third of China's export receipts was left abroad unreported according to Direction of Trade Statistics published by the International Monetary.[5]

An official market for foreign currency only started in 1979 when enterprises were allowed to hold hard currency or import at will, providing the basis for an exchange market. That was followed by a formal dual exchange rate system between 1981 and 1985, whereby there were two exchange rates, one for commodity trade and one for non-commodity trade. In 1986, we see the establishment of Foreign Exchange Adjustment Centers (FEACs)—swap centers—where Chinese enterprises and foreign investment corporations were permitted to transact. The swap rate was determined by the government on the basis of the official rate, and from 1988 onwards it was set through a managed floating system where market forces played some role. By 1988 many such local swap centers were established, as well as a national one in Beijing, and the total value of currency swapped accounted for one-third of national retained foreign exchanges and 18% of national imports. In January 1994, the official and swap market rates were unified at the prevailing market swap exchange rate and the issuance of retention quotas was terminated. There is no longer any requirement to obtain official approval for the purchase of foreign exchange for most trade and trade-related transactions contacted by domestic enterprises. With respect to capital transactions, the State Administration of Exchange Control has retained the responsibility. Restrictions, however, on international trade have been reduced substantially and the average tariff was 19.8% in 1996. Quantitative restrictions on current account transactions have been abolished in 1994.[6] In the context of negotiation for reaccession to WTO, the authorities have made offers on further trade liberalisation.

The changes in the exchange rate regime and the movement towards liberalisation of international transactions have been reflected in the black market premium —the spread between the black and swap exchange rate (see Fig. 1). The premium rose substantially throughout 1988 and reached a peak of more than 100% in mid 1989, before falling to a mere 10% at the end of 1995, and remaining at that level.

[4] The smuggling of goods might take place if tariffs are higher than the black market premium and the possibility and penalty of being caught are not very big.

[5] See Jianping (1998).

[6] See Tseng et al. (1994).

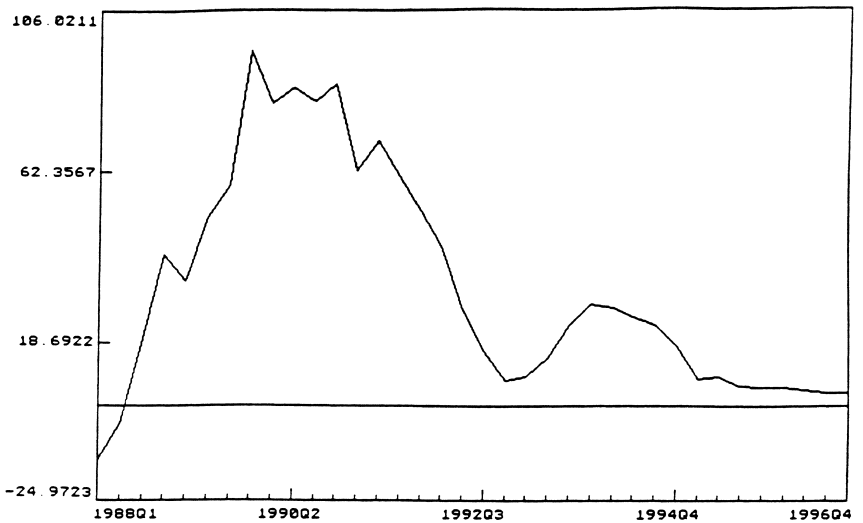


Fig. 1. Black market premium (%).

The substantial rise in 1989 could partially reflect the political upheaval of the so-called “Democracy Movement”.

## 3. The model

Our model is based on the seminal work by Blejer (1978). There are no interest-bearing assets, so interest rates are excluded from the specification of both the demand for domestic currency and the demand for foreign currency.[7] In developing countries such as China, substitution is likely to be between money and real assets rather than between money and financial assets. Moreover, there is limited range of financial assets, organised financial markets have a small size and interest rates are institutionally pegged. An important characteristic of our model is the explicit modelling of the foreign country, which enriches the dynamics. Finally, our specification provides a framework for examining Purchasing Power Parity (PPP) for economies where there is intervention in the foreign exchange market.

In the model the black market rate is determined by the interaction between supply of and demand for foreign currency in that market. The main sources of foreign exchange supply to the market are receipts from the overinvoicing of imports and underinvoicing of exports as well as receipts from tourism. The main

[7] In the Blejer model the domestic nominal interest rate is included implicitly in the demand for foreign currency.

determinant of these activities is the differential between the official and the black market rates. The greater the differential, the greater the profit possibilities and the higher the incentive to divert foreign currency to the black market. The supply function of foreign currency to the black market can be as follows:

$$\log S_b = c_0 + c_1(\log e_b - \log e_o), \quad c_1 > 0, \tag{1}$$

where $S_b$ is the supply of foreign currency to the black market, and $e_b$ and $e_o$ are the black market and official exchange rates, respectively.[8]

On the other hand, the demand for foreign currency in the black market is positively related to the return derived from holding this asset, which is a function of the expected rate of appreciation of the foreign currency in the black market. If we assume that economic agents in forming their expectations compare the behaviour of the exchange rate with the behaviour of the ratio between domestic and foreign level of prices, then the demand for foreign currency can be represented as follows:

$$\log D_b = b_0 + b_1(\log p - \log p^* - \log e_b), \quad b_1 > 0, \tag{2}$$

where $p$ and $p^*$ are the domestic and foreign price level, respectively. Thus, if $p$ has been rising faster than $p^*$ and this has not led to a corresponding increase in the black market exchange rate, the agents will expect the black market rate to depreciate by as mush as the observed inflation rate differential.

Equating the supply of and demand for foreign currency in the black market and solving for $e_b$, we get

$$\log e_b = a_0 + a_1 \log e_o + a_2(\log p - \log p^*), \tag{3}$$

where $a_1 = c_1/c_1 + b_1$ and $a_2 = b_1/c_1 + b_1$. $e_b$ is a weighted average of $e_o$ and the price differential which is in effect the Purchasing Power Parity exchange rate. If there is no official intervention in the foreign exchange market, either direct or indirect through the imposition of foreign exchange controls, $e_o$ will move in accord with PPP and will be equal to $e_o$, i.e. there will be no black market for foreign currency. If on the other hand, there is intervention in the foreign exchange market, then $e_o$ will be different from PPP rate, and $e_b$ will depend partly on $e_o$ and partly on the notional equilibrium rate defined by PPP.

Thus, our analysis apart from examining the behaviour of the black market rate, provides a framework for testing PPP for economies where there is intervention in the foreign exchange market. The emphasis of the current paper, however, is the interaction of monetary factors and real output with the exchange rates. Assuming therefore money market equilibrium in each of the two countries and that the

[8] Both exchange rates are defined as domestic currency per one unit of foreign currency.

demand for real money balances depends on real income and the rate of inflation, $\pi$, Eq. (3) can be written as follows:

$$\log e_b = a_0 + a_1 \log e_o + a_2 \log(m/m^*) - a_2 \lambda_1 \log y + a_2 \lambda_1^* \log y^* + a_2 \lambda_2 \log \pi - a_2 \lambda_2^* \log \pi^*, \quad (4)$$

where $m$ is the nominal supply, and the foreign country is denoted by an $^*$. The income and inflation elasticities are $\lambda_1$ and $\lambda_2$, respectively.[9] The model implies that an increase in the domestic money supply, initiated for example by an expansion of domestic credit, results in an ex ante disequilibrium in the money market. As economic agents get rid of their excess cash balances, domestic prices rise. That creates expectations of exchange rate depreciation and an increase in the demand for black market dollars. This in turn increases the differential between the official and the black market rate, raising the incentive to underinvoice exports, to smuggle exports, or to divert remittances through the black market. Although this increase in the supply of foreign currency in the black market will dampen the upward pressure on the black market rate, a higher stock of money will in general be associated with a depreciation of the black market rate.

On the other hand, an increase in real income in China will increase the demand for money, creating an excess demand for cash balances. As economic agents economise on their cash balances, domestic prices will fall. The reverse of what has been described above will take place and the black market rate will appreciate. In this model, as well as in all other monetary models, real factors affect the exchange rate through the money market.

## 4. Empirical evidence

### *4.1. Data*

We use end of quarter data for the period 1988 Q1 to 1996 Q4. The exchange rates are all expressed as domestic currency per US dollar. The black market quotations are taken from the World Currency Yearbook, while the swap rate and the Retail Price Index are taken from the World Bank database. US industrial production, consumer price index and money supply (M0) were collected from the OECD Main Economic Indicators. The industrial production and money supply (overall currency holdings) for China were taken from the State Statistical Bureau, Monthly statistics, and People's Bank of China, respectively.

The difference in the behaviour of the swap and black market rates is shown in Fig. 2. As can be seen, the black market rate, being free to respond to actual and

[9] In our estimation we have assumed that the inflation elasticity is the same for both countries to simplify the estimation process.

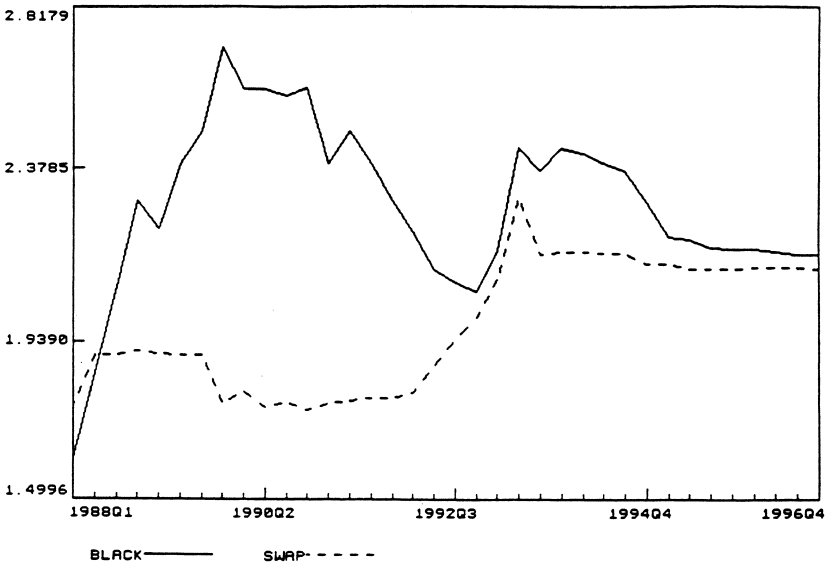


Fig. 2. Black and swap market exchange rates (in logarithms).

anticipated changes in economic conditions, has been more volatile than the swap rate.

### *4.2. Unit root tests*

In accordance with usual practice, all the series were initially tested for stationarity. Standard unit root tests of Dickey and Fuller (1981) and Phillips and Perron (1988) are biased towards the acceptance of the unit root hypothesis (Kiatkowski et al., 1992). The stationarity tests implemented here use the test suggested by Kiatkowski et al. (1992). The distribution theory used by the latter assumes that the series of interest has a short memory, that is its partial sum satisfies an invariance principle. However, Lee and Schmidt (1995) show that such a test is robust with respect to an alternative hypothesis of long memory. It can thus be used to distinguish short memory processes from stationary long memory ones.

The Kiatkowski et al (1992) test has two components: in the first the null hypothesis is the stationarity of the series in level ($m$); in the second it is the stationarity around a time trend ($t$). It is only when the first hypothesis is rejected that one should implement the second test. Results are given in Table 1. Tests implemented on the level of the series reject both hypotheses for all series except the inflation rate differential. We implemented the same tests with the series in first differences. As the null hypothesis of stationarity of the series in first

Table 1
Stationarity test a la Kiatkowski et al (1992)

| Lags | Level | | | | First difference | |
|---|---|---|---|---|---|---|
| | $m$ | | $t$ | | $m$ | |
| | 0 | 4 | 0 | 4 | 0 | 4 |
| $e_b$ | 0.89 | 0.35 | 3.16 | 0.83 | 0.57 | 0.30 |
| $e_o$ | 1.20 | 0.40 | 3.57 | 1.24 | 0.26 | 0.28 |
| $y^*$ | 3.40 | 0.82 | 3.27 | 0.98 | 0.25 | 0.15 |
| $y$ | 3.84 | 0.90 | 3.96 | 1.42 | 0.03 | 0.14 |
| $m/m^*$ | 2.55 | 0.61 | 0.57 | 0.16 | | |
| $\pi/\pi^*$ | 0.25 | 0.09 | | | | |

The critical value at 1% for $(m)$ is 0.347 and for $(t)$ is 0.119.

differences is unambiguously accepted we concluded that these series are integrated of order one.

Since in general the power of unit root tests is low we checked the result for the inflation rate differential by applying Johansen's maximum likelihood ratio test for cointegration, which is explained in the next section (cointegration of a single series implies stationarity). We found that the null hypothesis of a unit root was accepted when allowing for trend, and thus continued in the next section to test for cointegration.

### *4.3. Cointegration tests*

According to Eq. (4) there should be a long run equilibrium relationship between the black market rate, the swap rate, the money supplies in China and the US, and the level of real income and inflation rate in both of these countries. In our paper, we use the multiple cointegrating vector technique developed initially by Granger (1981) to explore this long-run relationship. We use the likelihood ratio test due to Johansen (1988) and Johansen and Juselius (1990). Let $z_t \equiv (e_b, e_o, m/m^*, y, y^*, \pi/\pi^*)$; and $n$ the number of variables in the system, six in this case. If $z_t$ is cointegrated, it can be generated by a vector error correction model (VECM):

$$\Delta z_t = \boldsymbol{\mu} + \sum_{i=1}^{p-1} \mathbf{G}_i \Delta z_{t-i} + \mathbf{G} z_{t-1} + \boldsymbol{\varepsilon}_t, \tag{5}$$

where $\mu$ is a $6 \times 1$ vector of drift, G's are $6 \times 6$ matrices of parameters, and $\varepsilon_t$ is a $6 \times 1$ white noise vector. The Johansen trace test statistic of the null hypothesis that there are at most $r$ cointegrating vectors $0 \le r \le n$ is as follows:

$$\text{trace} = -T \sum_{i=r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right), \tag{6}$$

Table 2
Cointegration test — Johansen Trace statistic

| | Statistic | 95% Critical value |
|---|---|---|
| $H_0$: $r = 0$ | 92.02 * | 83.18 |
| $H_0$: $r \leq 1$ | 40.12 | 59.33 |
| $H_0$: $r \leq 2$ | 19.48 | 39.81 |
| $H_0$: $r \leq 3$ | 7.05 | 24.05 |
| $H_0$: $r \leq 4$ | 3.15 | 12.36 |
| $H_0$: $r \leq 5$ | 0.19 | 4.16 |

If $r$ denotes the number of significant cointegrating vectors, the Johansen statistics test the hypotheses of at most 5, 4, 3, 2, 1 and 0 cointegrating vectors. The statistics include a finite sample correction (see Reimers, 1992).

where $\hat{\lambda}$'s are the $n-r$ smallest squared canonical correlations of $z_{t-1}$ with respect to $\Delta z_t$ corrected for lagged differences and $T$ is the sample size actually used for estimation.

The Johansen trace statistic has also been corrected for small sample bias (see Reimers, 1992).[10] Thus, we use $(T - np)$ in Eq. (6) instead of $T$. The lag length is chosen by applying the Schwarz information criterion (SIC) on the undifferenced VAR developed by Schwarz (1978).[11]

We have also included seasonal dummy variables to take account of the seasonality of exports and imports and a dummy to take into account the unification of the swap and official rates. A multistep dummy variable to account for the reduction in tariffs was also considered but found to be statistically insignificant. The results are shown in Table 2. The hypothesis of zero cointegrating vectors ($H_0$: $r = 0$), against the alternative of one or more cointegrating vectors, is rejected at the 5% level of significance. On the other hand, the hypothesis of at most one cointegrating vector ($H_0$: $r \leq 1$) is not rejected. The implied long-run relationship is given below with the asymptotic standard errors in brackets:

$$\log e_b = \underset{(0.91)}{1.95}\log(m/m^*) + \underset{(0.58)}{0.85}\log e_o - \underset{(0.75)}{2.63}\log y + \underset{(0.97)}{3.13}\log y^* + \underset{(2.15)}{0.16}\log(\pi/\pi^*). \quad (7)$$

The coefficients have the expected signs and are statistically significant apart from relative inflation. We thus reestimated the cointegrating relation, imposing the overidentifying restriction that this coefficient is zero.[12] The log-likelihood

[10] The trace test appears to be more robust to nonnormality of errors compared to the maximal eigenvalue (see Cheung and Lai (1993) for Monte Carlo results on this issue).

[11] Reimers (1992) finds that the SIC does well in selecting the lag length.

[12] See Johansen and Juselius (1992).

ratio statistic was $CHSQ(1) = 0.005$, which is not statistically significant and hence suggests that the restriction cannot be rejected.[13] The implied long-run relationship under that restriction is

$$\log e_b = \underset{(0.74)}{1.91}\log(m/m^*) + \underset{(0.38)}{0.88}\log e_o - \underset{(0.65)}{2.60}\log y + \underset{(0.79)}{3.08}\log y^*. \quad (8)$$

From Eq. (3) in Section 3, $e_b$ is a weighted average of $e_o$ and the price differential which is in effect the PPP exchange rate. The weights depend on the degree of intervention in the foreign exchange market. In the case where there is substantial intervention, the weight attached to $e_o$, $a_1$, will be small, while the weight attached to the PPP rate, $a_2$, will be big. The results in Eq. (8) with and $a_1 = 0.88$ and $a_2 = 1.91$ indicate that there is substantial intervention in the foreign exchange market. The sum of the two coefficients, however, exceeds one, which is the implication of the theoretical model. Imposing the restriction that $\alpha_1 + \alpha_2 = 1$ re-estimating the model, we find the log-likelihood ratio statistic to be $CHSQ(1) = 10.29$, which is statistically significant and suggests that the restriction cannot be accepted.

A possible explanation for this result could be the fact that our theoretical model does not take into account what is revealed by the short-run dynamics in the empirical section of a substantial negative effect of the black market exchange rate on real output. According to the model, the increase in the money supply causes domestic prices to rise and creates expectations of exchange rate depreciation, which increases the demand for black market dollars and causes a depreciation of the black market rate. This seems, however, not to be the end of the story. The black market rate depreciation has a substantial effect on real output, which feeds into the demand for real money balances, causing prices and the black market rate to rise even further.

Looking at the income elasticities, the values are in accord with those of other studies.[14]

### *4.4. Short-run dynamics*

As well as examining the long-run relationship of the variables, we wanted to explore the short-run dynamics by estimating the VECM. Since each equation has the same lag length, we estimate the six equations using OLS as the estimates are consistent and asymptotically efficient.[15] The results with diagnostic tests are presented in Table 3. The models on the whole are well specified. Various points

[13] Introducing the rate of inflation of the two countries separately and testing first the restriction that the two coefficients are the same, before imposing the restriction that they are zero, we find that neither restriction can be rejected. The results show again, that the rates of inflation do not affect the black market rate in the long run.

[14] See e.g. Girardin (1996) for China and Boughton (1991) for US.

[15] See e.g. Enders (1995).

Table 3
Error correction models

| | Coefficient | *T*-ratio |
|---|---|---|
| *Dependent variable:* $de_{b,t}$ | | |
| $de_{b,t-1}$ | 0.219 | 1.615 |
| $de_{o,t-1}$ | 0.015 | 0.061 |
| $dy^*_{t-1}$ | 0.348 | 0.231 |
| $dy_{t-1}$ | 0.705 | 3.939 |
| $d(\pi/\pi^*)_{t-1}$ | −0.001 | −0.001 |
| $d(m/m^*)_{t-1}$ | −0.552 | −1.267 |
| $\text{ecm}_{t-1}$ | −0.241 | −5.099 |
| *De* | 0.016 | 0.177 |
| *S*1 | −0.144 | −2.140 |
| *S*3 | −0.199 | −3.563 |
| $\bar{R}^2$ | 0.49 | |
| Serial correlation | CHSQ(4) = 6.560 | |
| Functional Form | CHSQ(1) = 0.009 | |
| Normality | CHSQ(2) = 0.221 | |
| Heteroskedasticity | CHSQ(1) = 0.072 | |
| *Dependent variable:* $de_{o,t}$ | | |
| $de_{b,t-1}$ | −0.129 | −1.154 |
| $de_{o,t-1}$ | 0.015 | 0.031 |
| $dy^*_{t-1}$ | 0.392 | 0.241 |
| $dy_{t-1}$ | 0.101 | 0.715 |
| $d(\pi/\pi^*)_{t-1}$ | −0.381 | −0.514 |
| $d(m/m^*)_{t-1}$ | 0.167 | 0.510 |
| $\text{ecm}_{t-1}$ | −0.019 | −0.564 |
| *De* | −0.024 | −0.320 |
| *S*1 | −0.010 | −0.317 |
| *S*3 | −0.016 | −0.356 |
| $\bar{R}^2$ | −0.22 | |
| Serial correlation | CHSQ(4) = 6.587 | |
| Functional Form | CHSQ(1) = 1.494 | |
| Normality | CHSQ(2) = 49.467 | |
| Heteroskedasticity | CHSQ(1) = 0.041 | |
| *Dependent variable:* $dy_t$ | | |
| $de_{b,t-1}$ | −0.357 | −3.497 |
| $de_{o,t-1}$ | 0.130 | 0.686 |
| $dy^*_{t-1}$ | −0.355 | −0.313 |
| $dy_{t-1}$ | −0.639 | −4.743 |
| $d(\pi/\pi^*)_{t-1}$ | 2.881 | 3.368 |
| $d(m/m^*)_{t-1}$ | −0.371 | −1.134 |
| $\text{ecm}_{t-1}$ | −0.200 | −5.650 |
| *De* | −0.022 | −0.326 |
| *S*1 | 0.002 | 0.037 |
| *S*3 | 0.068 | 1.637 |
| $\bar{R}^2$ | 0.84 | |
| Serial correlation | CHSQ(4) = 3.381 | |

Table 3 (*continued*)

| | Coefficient | *T*-ratio |
|---|---|---|
| *Dependent variable:* $dy_t$ | | |
| Functional Form | CHSQ(1) = 0.036 | |
| Normality | CHSQ(2) = 4.032 | |
| Heteroskedasticity | CHSQ(1) = 0.244 | |
| *Dependent variable:* $dy_t^*$ | | |
| $de_{b,t-1}$ | −0.009 | −0.532 |
| $de_{o,t-1}$ | −0.020 | −0.603 |
| $dy_{t-1}^*$ | 0.204 | 0.996 |
| $dy_{t-1}$ | 0.029 | 1.201 |
| $d(\pi/\pi^*)_{t-1}$ | 0.109 | 0.318 |
| $d(m/m^*)_{t-1}$ | −0.024 | −0.412 |
| $\text{ecm}_{t-1}$ | −0.014 | −2.167 |
| *De* | 0.016 | 1.282 |
| *S*1 | −0.003 | −0.390 |
| *S*3 | $-0.947\times10^{4}$ | −0.012 |
| $\bar{R}^2$ | −0.07 | |
| Serial correlation | CHSQ(4) = 1.842 | |
| Functional Form | CHSQ(1) = 5.236 | |
| Normality | CHSQ(2) = 3.195 | |
| Heteroskedasticity | CHSQ(1) = 1.802 | |
| *Dependent variable* $d(\pi/\pi^*)_t$ | | |
| $de_{b,t-1}$ | −0.026 | −0.974 |
| $de_{o,t-1}$ | 0.059 | 1.167 |
| $dy_{t-1}^*$ | −0.279 | −0.927 |
| $dy_{t-1}$ | −0.028 | −0.807 |
| $d(\pi/\pi^*)_{t-1}$ | −0.352 | −1.549 |
| $d(m/m^*)_{t-1}$ | −0.027 | −0.318 |
| $\text{ecm}_{t-1}$ | −0.007 | −0.752 |
| *De* | 0.029 | 1.601 |
| *S*1 | −0.010 | −0.796 |
| *S*3 | 0.030 | 2.692 |
| $\bar{R}^2$ | 0.44 | |
| Serial correlation | CHSQ(4) = 0.907 | |
| Functional Form | CHSQ(1) = 1.443 | |
| Normality | CHSQ(2) = 2.947 | |
| Heteroskedasticity | CHSQ(1) = 0.336 | |
| *Dependent variable* $d(m/m^*)_t$ | | |
| $de_{b,t-1}$ | −0.145 | −1.593 |
| $de_{o,t-1}$ | −0.089 | −0.525 |
| $dy_{t-1}^*$ | 0.750 | 0.742 |
| $dy_{t-1}$ | 0.093 | 0.773 |
| $d(\pi/\pi^*)_{t-1}$ | 1.004 | 1.314 |
| $d(m/m^*)_{t-1}$ | 0.520 | 1.777 |
| $\text{ecm}_{t-1}$ | 0.018 | 0.583 |

*(continued on next page)*

Table 3 (*continued*)

| | Coefficient | *T*-ratio |
|---|---|---|
| *Dependent variable* $d(m/m^*)_t$ | | |
| *De* | −0.059 | −0.955 |
| *S*1 | −0.047 | −1.060 |
| *S*3 | 0.070 | 1.889 |
| $\bar{R}^2$ | 0.40 | |
| Serial correlation | CHSQ(4) = 21.194 | |
| Functional Form | CHSQ(1) = 0.411 | |
| Normality | CHSQ(2) = 1.000 | |
| Heteroskedasticity | CHSQ(1) = 0.448 | |

$ecm_{t-1}$ is the error correction term; *de* is a dummy variable for the unification of swap and official rates in 1994; and S1 and S3 are seasonal dummy variables for the first and third quarters. The sample period is 1988Q1 to 1996Q4.

can be made. First, the error correction term in the swap rate equation is statistically insignificant, in contrast to that in the black market rate. That indicates that the swap rate is weakly exogenous as one would have expected, since it is managed by the authorities. Similarly, in the relative money supply equation and the inflation differential equations, the error correction term is statistically insignificant. The results are not surprising. Both variables are in relative terms to US and in addition, the relative inflation rate was found to be statistically insignificant in the long-run cointegrating relationship. Furthermore, monetary policy in China during this period relied substantially on the cash plan, which was prepared by the People's Bank of China at the end of each year based on estimates received from the municipal and prefecture level. Although the expected demand for currency was calculated on the basis of economic fundamentals, such as the real growth rate of the economy and the expected rate of inflation, final approval was in the hands of the State Council and subject to a host of political influences.[16]

Second, the error correction term in the black market equation indicates that the black market rate declines by 24% in the first quarter following a deviation from long-run equilibrium. From the short-run dynamics only real output and the black market rate are statistically significant. The effect of real output is positive contrary to our expectations. A possible explanation could be that in the short-run an increase in real output puts upward pressure on the black market rate through its effect on smuggled imports. The equation explains 49% of the variation in the black market return.

Third, the error correction term in the Chinese output equation is 0.20 and the adjusted $R^2$ is about 84%. The black market rate exerts in the short run a negative and statistically significant effect on production. An explanation for this result could be found in models, which have looked closely at the connection between

[16] See Mehran et al. (1996).

the black market and illegal trade. For example, Kamin (1993) explains how the high black market premium increases export underinvoicing as well as export smuggling resulting in a reduction in officially measured exports. This drop in export proceeds leads to reserve losses and to a deflationary effect on the economy. Relative inflation also influences production in the short-run. An increase in relative inflation increases the rate of growth of output. This is in contrast to standard theory. Empirical regulation, however, of the behaviour of inflation and growth show that inflation of less than 20% is associated with positive growth.[17]

Fourth, the error correction term in the output growth equation in US is surprisingly statistically significant, but small. In the short-run, an increase in the Chinese output growth has a small and statistically significant effect at the 24% level. When the statistically insignificant variables were excluded from the error correction model and the VECM was reestimated using maximum likelihood estimation of seeming unrelated regression equations (SURE), the *t*-ratio increased to 2.50. The effect of Chinese output growth on US could be the result of substantial trade between the two countries. Over the period 1991–1996 the average annual growth of US imports from China was 19% compared to 5% from the rest of Asia and 9% from the rest of the world. It should be noted, however, that the explanatory power of the reestimated error correction model, although higher than previously, is still small—adjusted $R^2$ was equal to 7%.

Finally, the relative inflation equation indicates the inflationary consequences of China's exchange rate policy in the reforming years. The change in the swap rate has a positive and statistically significant effect at the 25% level. A 1% devaluation will cause the change in the relative rate of inflation to rise by 0.06 of 1%. The effect of the unification of the swap and the official rates in January 1994, represented by the dummy variable *de*, had also a positive once-and-for-all effect on the rate of relative inflation.[18] Thus, the inflationary cost of the unification and in effect devaluation of the official rate was mild. That could have been due to the handing out of subsidies.[19]

### *4.5. Impulse response analysis*

We next subjected our cointegrated vector autoregressive system (VAR) to impulse response analysis in order to examine how, for example, a depreciation of

[17] See Bruno (1995).

[18] When the statistically insignificant variables were excluded from the inflation equation and the VECM was reestimated using SURE method the *t*-ratio of *de* increased to 1.833 and the adjusted $R^2$ to 48%. The Wald statistic for the coefficient to be zero was 3.36. That is the restriction could not be rejected at the 6% level of significance.

[19] Lu and Zhang (1998) arrived at the same conclusion when exploring the causes of inflation during the period 1986–1993.

the swap rate, affects the other variables. Lutkepohl and Reimers (1992) show that innovation accounting can be used to obtain information concerning the interactions among the variables. They develop the asymptotic distribution of the impulse responses and forecast error variance components of a Gaussian VAR process with cointegrated variables. They suggest that one estimates the undifferenced VAR of VECM of Eq. (5)

$$z_t = \mu + \mathrm{A}_1 Y_{t-1} + \ldots + \mathrm{A}_p Y_{t-k} + \varepsilon_t, \tag{9}$$

where $\mathrm{A}_i$ are $6 \times 6$ coefficient matrices, by multivariate least squares as the resulting estimator has an asymptotic normal distribution where covariance matrix may be estimated by the usual formula for stationary processes.

Eq. (9) can be transformed to a vector moving average representation given below, which can be used to examine the interactions between the variables

$$Y_t = \mu + \sum_{i=0}^{\infty} \phi_i \varepsilon_{t-i}. \tag{10}$$

The coefficients of $\phi_i$ can be used to generate the effects of $\varepsilon_{e_o}$, $\varepsilon_{e_b}$ $\varepsilon_y$ $\varepsilon_{y^*}$, $\varepsilon_{\pi/\pi^*}$ and $\varepsilon_{m/m^*}$ shocks on the entire time paths of $e_o$, $e_{b,}$ $y$, $y^*$, $\pi/\pi^*$ and $m/m^*$. The shocks can take the form of one standard error of each variable. The accumulated effects of the impulses in $\varepsilon_{e_o}$, $\varepsilon_{e_b}$ $\varepsilon_y$ $\varepsilon_{y^*}$, $\varepsilon_{\pi/\pi^*}$ and $\varepsilon_{m/m^*}$ can be obtained by the appropriate summation of the coefficients of the impulse response function. Since the VAR is underidentified, Choleski decomposition is often used to orthogonalise the innovations. The results of this approach depend, however, on the ordering of the variables in the VAR. In a our paper, we applied the generalised impulse response analysis suggested by Koop et al. (1996), which does not have that shortcoming. This is achieved by examining the shock in one of the variables, and integrating the effects of other shocks using an assumed or historically observed distribution of the errors.

The results of the exercise following a one unit shock in the swap rate (measured as one standard error) are given in Fig. 3. It should be noted that the lag structure of the VAR has already been selected in the cointegration exercise using the SIC. As it can be seen the black market rate depreciates, also confirming the long-run relationship between these two variables. The effect on the relative rate of inflation is positive but short-lived, implying a small trading sector and a lack of substitutability between traded and non-traded sectors. The fact that devaluation does not affect relative inflation permanently leaves room for a long-term effect on output. This is confirmed by looking at the behaviour of output. There is a positive and substantial short-term effect, which lasts for two quarters before turning negative for a quarter and then rising again. Thus, the devaluation of the exchange rate has a long-run positive effect on the real economy in China, albeit a small one.

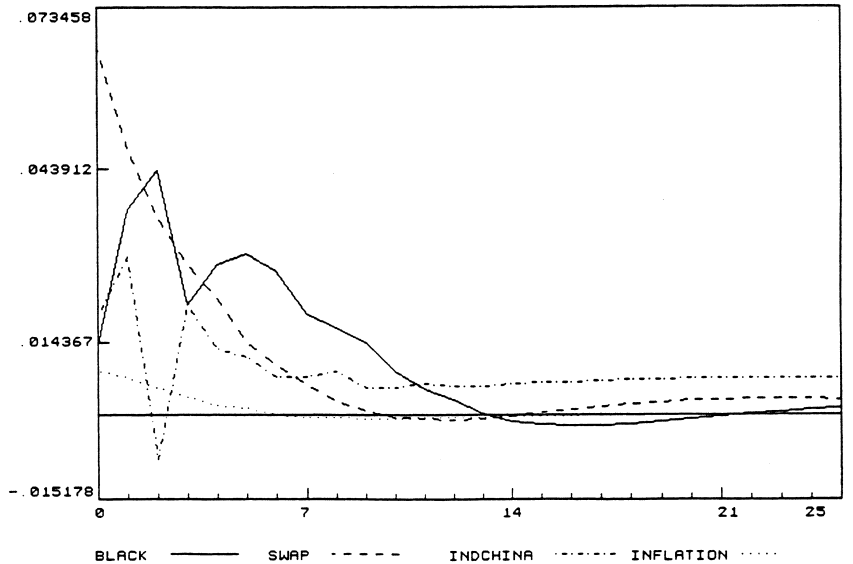


Fig. 3. Generalized impulse responses to one SE shock in the equation for SWAP.

The negative effect of the black market rate on production is confirmed in Fig. 4. A one-unit shock in the black market rate reduces output permanently. The interaction between production in the two countries is captured in Fig. 5. A one-unit shock in output in China has a small but rising effect on US output.

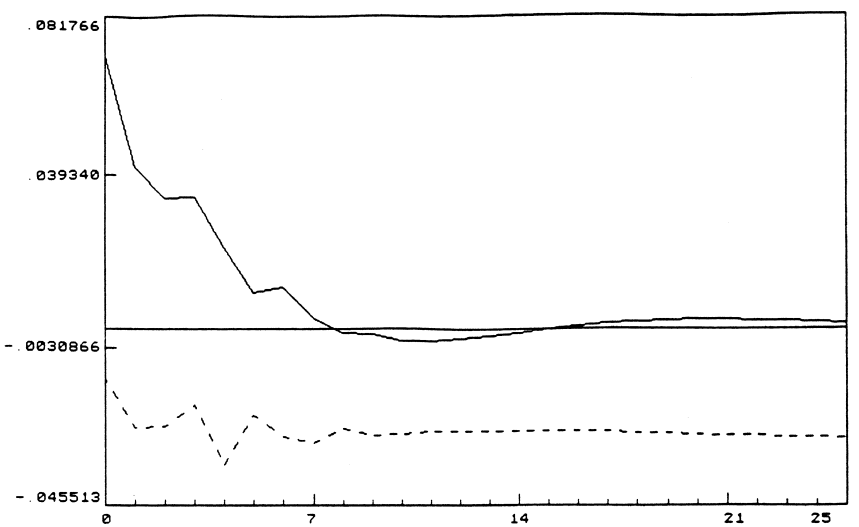


Fig. 4. Generalized impulse response to one SE shock in the equation for BLACK.

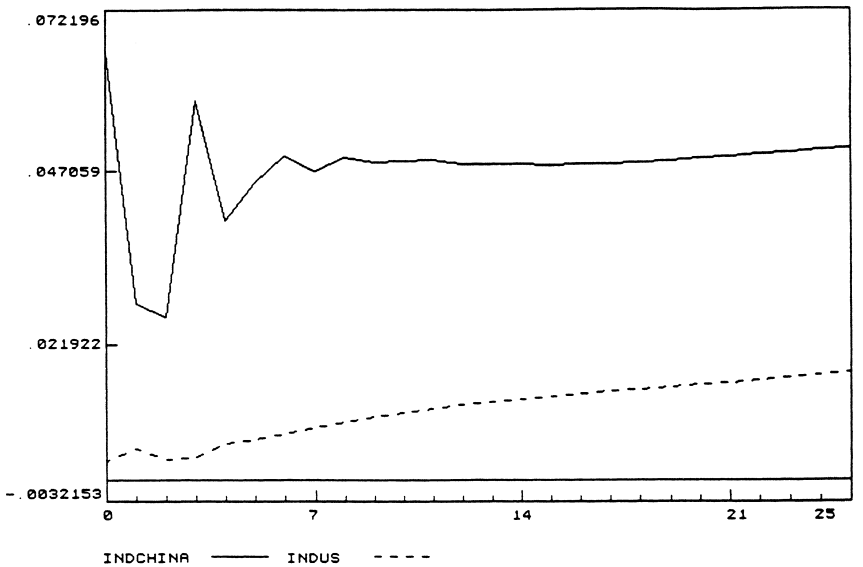


Fig. 5. Generalized impulse Responses to one SE shock in the equation INDCHINA.

In Fig. 6, we explore the effects of an expansionary monetary policy. As it can be seen, it has no effect on relative inflation, but it has a permanent effect on the level of output. Two further points can be made. First, there is a short-term

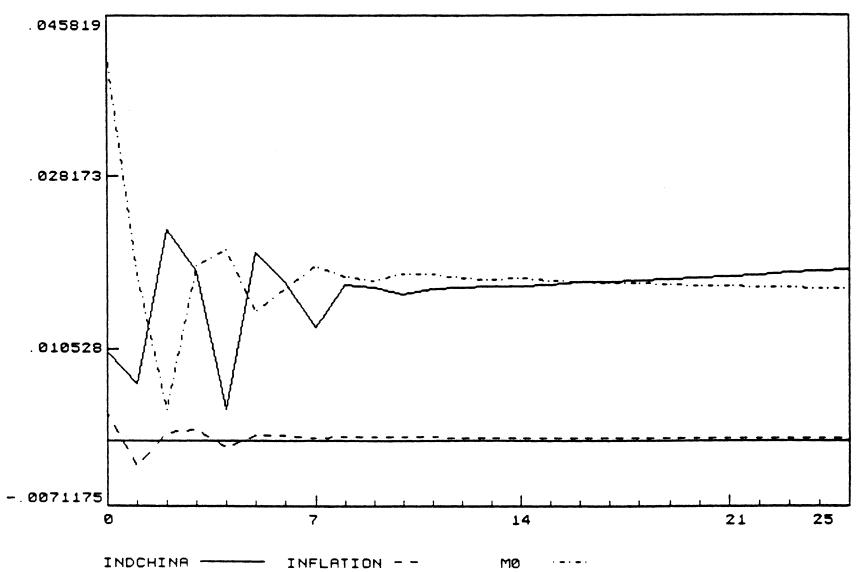


Fig. 6. Generalized impulse responses to one SE shock in the equation for M0.

countercyclical relationship between money supply and real output, which lasts for seven quarters. According to Bennett and Dixon (1998), who developed a three sector macro-model—food, non-traded industrial goods and exports—of the Chinese economy in which the activity of state owned enterprises, which produce non-traded goods, is constrained by the state imposed credit plan for working capital, monetary expansion can have a contractionary effect on output. Second, after seven quarters money supply expansion produces a similar increase in real output.

## 5. Conclusion

In this paper, we have examined the behaviour of exchange rates in China during the recent period of trade and exchange system reforms. We developed a simple theoretical model, which, although has limitations, e.g. not allowing for smuggling activity in the transactions demand for foreign currency, is found to explain relatively well the behaviour of the black market rate and its interactions with the economy.

The following are some of the conclusions from our analysis. First, we found that there is a long-run relationship between the black market rate, the swap rate, Chinese output, US output and relative money supply. The two exchange rates are found to move in the same direction. Real output in both countries is found to affect the black market rate through the demand for money, a characteristic of monetary models compared to the balance of payments approach. In addition, an expanding money supply causes the black market rate to depreciate.

Second, the error correction models have revealed a variety of interesting interactions between the variables. For example, the swap rate has been found to be weakly exogenous, while the black market rate, being market determined, adjusts to restore long-run equilibrium in the aftermath of a shock. At the same time, the black market rate return has a substantial negative effect on output growth. The results have also brought out the importance of the Pacific-Basin region for the US economy. Chinese output growth has a small effect on US growth. Finally, monetary policy is not affected by economic fundamentals but by political considerations. This latter result, however, could be sample dependent. As discussed in Yu (1997), bank credits and money aggregates were exogenously determined during tight money periods, but not during boom years. Our sample period is characterised by two restrictive periods, the first one started in September 1988 and the second in July 1993 and thus, our results might be dominated by these events.

Third, the impulse response analysis highlights the effects of monetary and exchange rate policy. Monetary policy is not found to be neutral but to affect real output without raising relative inflation. At the same time, the inflationary pressures of devaluation are short-lived, while there is a long-term effect on real output.

These empirical findings show that the inflationary consequences of China's exchange rate policy in the reforming years could not have been sizeable. This is also supported by the fact that the unification of the official and swap rates in 1994 did not have a big effect on the change of relative inflation. The moderate inflation cost of devaluation may enable the Chinese government to put more weight on external competitiveness.

Our results imply that more efforts should be made to discourage black market activities because of its negative effect on real output. Further liberalisation of the foreign exchange market, for example lifting controls on capital flows, could reduce the motivation for participating in the black market. Such a recommendation, however, should be treated with caution for two reasons. First, it is based on the assumption that the officially measured output is a good proxy for the overall output, which includes smuggling activity. Secondly, it could make China prone to the same type of short-term volatile capital inflows which have proved extremely disruptive in most Asian countries.

Furthermore, our findings indicate, subject to the caveats mentioned, that a more expansionary monetary policy stance in China might be a suitable antidote to the deflationary impact of the financial crisis which has swept the region since mid-1997. Devaluation, which could also be used since it has been found to have a long-term effect on output, could trigger another round of devaluations by the South East Asian countries with disastrous effects on the world economy.

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## References

Bennett, J. Dixon, H., 1998. "Monetary Policy and Credit in China: A Theoretical Analysis". Discussion Paper, University of Wales Swansea.

Blejer, M.L., 1978. Exchange restrictions and the monetary approach to the exchange rate. In: Frenkel, J.A., Johnson, H.G. (Eds.), The Economics of Exchange Rates: Selected Studies. Addison-Wesley, Reading.

Boughton, J.M., 1991. Long-run money demand in large industrial countries. IMF Staff Papers 38, 1–32.

Bruno, M., 1995. Does inflation really lower growth? Finance and Development, September.

Cheung, Y.W., Lai, K.S., 1993. Finite-sample Sizes of Johansen's Likelihood Ratio for Cointegration. Oxford Bulletin of Economics and Statistics 55, 313–328.

Dickey, D.A., Fuller, W.A., 1981. Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica 49, 1057–1072.

Enders, W., 1995. Applied Econometric Time Series. Wiley, United States.

Girardin, E., 1996. Is there a long run demand for currency in China? Economic Planning 29, 169–184.

Granger, C.W.J., 1981. Some properties of time series data and their use in econometric model specifications. Journal of Econometrics 28, 121–136.

Jianping, D., 1998. China's foreign exchange black market and exchange filght: analysis of exchange rate policy. The Developing Economies 36, 24–44.

Johansen, S., 1988. Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control 12, 231–254.

Johansen, S., Juselius, K., 1990. Maximum likelihood estimation and inference on cointegration with applications to the demand for money. Oxford Bulletin of Economics and Statistics 52, 169–210.

Johansen, S., Juselius, K., 1992. Testing structural hypotheses in a multivariate cointegration analysis of the PPP and UIP for UK. Journal of Econometrica 53, 211–244.

Kamin, S.B., 1993. Devaluation, exchange controls, and black markets for foreign exchange exchange. Journal of Development Economics 40, 151–169.

Kiatkowski, D., Phillips, P.C.B., Schmidt, P., Shin, Y., 1992. Testing the null hypothesis of stationarity against the alternative of a unit root. Journal of Econometrics 54, 159–178.

Koop, G., Pesaran, M.H., Potter, S.M., 1996. Impulse response analysis in non-linear multivariate models. Journal of Econometrics 74, 119–147.

Lee, D., Schmidt P., 1995. "On the Power of the KPSS Test against Fractionally Integrated Alternatives". Working Paper. Michigan State University.

Lu, M., Zhang, Z, 1998. "Exchange Rate Reform and its Inflationary Consequences: An Empirical Analysis for China". Discussion Paper, University of Southampton.

Lutkepohl, H., Reimers, H.E., 1992. Impulse response analysis of cointegrated systems. Journal of Dynamics and Control 16, 53–78.

McDermott, J., 1989. Foreign exchange rationing and employment in industrialising countries. Journal of International Economics 27, 245–264.

Mehran, H., Quintyn, M.T., Nordman, T., Laurens, B., 1996. "Monetary and Exchange System Reforms in China: An Experiment in Gradualism". IMF Occasional Paper, NO. 141.

Phillips, P.C.B., Perron, P., 1988. Testing for a unit-root in time series regression. Biometrica 75, 335–346.

Phylaktis, K., 1991. The black market for dollars in Chile. Journal of Development Economics 37, 155–172.

Phylaktis, K., 1996. Black market of foreign currency: a survey of theoretical and empirical issues. Financial Markets, Institutions and Instruments 7.

Reimers, H.E., 1992. Comparisons of tests for multivariate cointegration. Statistical Papers 33, 335–346.

Schwarz, G., 1978. Estimating the dimension of a model. The Annuals of Statistics 6, 461–464.

Tseng, W., Khor, H.E., Kochhar, K., Mihaljek, D., Burton, D., 1994. "Economic Reform in China: A New Phase". IMF Occasional Papers, No.114.

Yin, J.Z., Stoever, W., 1994. Testing the causes of discontinuities in the black market exchange rate in China. World Development 22, 1413–1424.

Yu, Q., 1997. Economic fluctuation, macro control, and monetary policy in the transitional Chinese economy. Journal of Comparative Economics 25, 181–195.

World Bank, 1997. "China Engaged: Integration with Global Economy", Report on China 2020, Washington D.C.

World Currency Yearbook. New York. Various issues.